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AN IMPROVING PERSPIRATION FASTNESS OF ANNATTO NATURAL DYE ON THE COTTON FABRIC

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ABSTRACT

Natural dyes/colorants derived from flora and fauna are believed to be safe because of non-toxic, non-carcinogenic and biodegradable nature. Further, natural dyes do not cause pollution and waste water problems. Above advantages are true. But there are some drawbacks with natural dyes are poor color fastness and low level dyeing. In this paper, showed the improvement of annatto natural dye acidic and alkaline perspiration fastness with eco-friendly dye fixing agents on cotton. Eco-friendly mordants (alum, stannous chloride and ferrous sulphate) were used for pre-mordanting the myrobalan treated fabrics for fastening of the imparted colours. Further, the dyed fabrics were post-treated with eco-friendly dye fixing agents such as : vinegar (CH_3COOH), Alum Alk $(SO_4)_2$, Ammonia (NH_3), Lime juice, and Calcium chloride ($CaCl_2$) for obtaining better colour fastness than un-treated cotton fabrics. Finally, these posts-treated fabrics were observed with different shades of colour and acidic and alkaline perspiration colour fastness test was conducted and as the dyed cotton fabrics were observed with the different shades of colour and acidic and alkaline fastness tests were conducted and assessed the acidic and alkaline perspiration samples of the colour change and staining by using Grey Scale and Blue Wool Scale as per the ASTM standards.

KEYWORDS: Natural Dyes, Bixaorellana, Fixing Agents, Colour Fastness Acidic Perspiration & Alkaline Perspiration

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Original Article

INTRODUCTION

India is one of the biggest plant biodiversity having 11th rank in the world. It has around 490,000 plant species and there is no distrust that the plant kingdom is a treasure-house for diverse natural products (Neha Grover et al., 2011)). Here, the dye is the product that comes from nature. Colour from leaves, fruits, seeds, wood and roots were used as colouring matter for textiles and used as painting in arts and crafts. Natural dyes are the environmental friendly which are substituted for synthetic dyes, no pollutants are released into the environment and harmful gases like as synthetic dyes as well as disinfected, user friendly and permanent than other colorants. The substitution of the natural dyes could happen when the introduction of synthetic dyes due to viable colouring property of the natural dyes (Kumaresan et al., 2011)).

Now a days, in the textile processing many poisonous dyes and chemicals are used. So that with this process, many harmful chemicals are released into the fields, ponds or rivers without waste water treatment. As a result, the workers and people get in touch with the discharge water, suffer from different skin diseases and respiratory problems. Due to an increasing awareness about health conscious among people and the demands for producing textile products during the environment friendly and sustainable dyes and dyeing processes. At present, many synthetic dyes are banned which are carcinogenic and allergenic dyes. But many dyes are not banned completely yet. So, may not be completely safe (Choudhury, 2018).

Hence, using of eco-friendly and biodegradable dyes for the application of textile is only the main concern worldwide. The natural dyes from plants were traced long time ago. Parts of the plants can be used for extraction of natural dye. India is the richest source for plant dyes. There are nearly 450 plants were found for yielding the colour. The dye can be extracted from different parts of the plants such as seeds, flowers, leaves and barks (Patil et al., 2016).

But there are many drawbacks by the use of natural dyes in the textile dyeing like colour yield, poor colourfastness, un-even dyeing, the difficulty of the dyeing process, reproducibility results, limited shades, blending problems, etc. But these problems can be overcome by after treatments with dye fixing agents. Some studies proved to improve the colourfastness by using Indo fix WA as the chemical was preferred because of its easy availability and low cost. From the study, it can be conducted that after-treatment has improved the colour fastness properties of direct dyed (Indigo red) fabric. Colourfastness to sunlight was observed better. After treatment, it has increased the colourfastness properties in both dry and wet crocking (Sharma et al., 1993).Some additives can also be improved this default of natural dyes (Daniela Cristea et al., 2005).

Another study was proved the improvement of the colourfastness with ammonia after-treatment on wool yarns dyed with annatto dye extraction. The dyeing was done at 15% dye concentration and mordated with stannous chloride and then post treated with different percentages of ammonia solution. After that, the treated samples were assessed to colour strength, CIE-Lab values and fastness properties of all dyed woollen yarns. The *K/S* value of annatto dyed wool was found to increase after treated with ammonia was studied by Shahid-ul-Islam et al., 2014.

In the present study, five eco-friendly dye fixing agents which are environment friendly, easily available, available at low-cost and used for domestic purpose were used to improve the perspiration fastness of annatto natural dye and mordanted cotton.

MATERIALS

Source

Annatto seed extract is a natural dye, which is obtained from the outer coatings of the seeds of Bixaorellana L. Belonging to the family Bixaceae. It is mostly cultivated intropical areas of India for commercial production(Collins et al 1992, Evans et al., 2000., and Vanker et al., 2000). It has been considered safe for human consumption. In the present study, the seed extracts were applied to the 100 % soft cotton fabric was used as substrate (Figure 1).

Figure 1: Annatto Seeds

(https://www.researchgate.net/publication/269846386_

ANNATTO_ECO_FRIENDLY_AND_POTENTIAL_SOURCE_FOR_NATURAL_DYE)

Substrate

The 100 % soft cotton fabric was used as substrate.

Chemicals for Mordanting

The three eco-friendly mordants, such as alum (AlK $(SO_4)_2$Stannus Chloride ($SnCl_2$) and Ferrous Sulphate ($FeSO_4$).

Eco-Friendly Fixing Agents

Fixing agents such as vinegar, alum (AlK $(SO_4)_2$, ammonia NH_3, lime juice and calcium chloride $CaCl_2$ (Figure 2) were selected, as they were eco-friendly and easily available **(Figure 2)**.

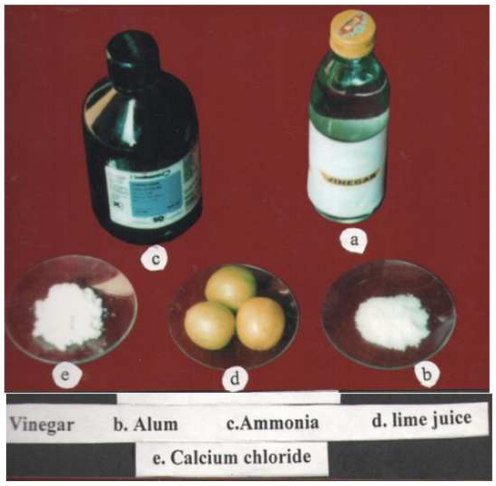

Figure 2: Eco-Friendly Dye Fixing Agents

Method

Scouring of Cotton Cloth

Cotton cloth used for dyeing was boiled in non- ionic detergent (2g/ liter of water) NaOH solution (1g/ liter of water) for one hour. The fabric was then thoroughly rinsed to remove traces of detergent and alkali and dried in the shade (Davy et al., 2002).

Pretreatment of Cotton with Myrobalan

Pre-treatment of scouring cotton with 20 percent concentration of myrobalan for increased the depth of the shade obtained. It was developed by Devy.et al. (2002).

Extraction of Dye From seeds of Annato

An Alkaline extraction method with the addition of one percent sodium carbonate was found suitable for extraction of natural dyes from annatto (**Figure 3)**.

Figure 3: Alkaline Extraction of Annatto

Dyeing and Mordanting

The clean scouring cotton cloth was subjected to three eco-friendly mordants in pre-mordanting method for 30 minutes. The Alum with 5%, 10% and 15%, Stannous Chloride and Ferrous Sulphate with 1%, 2% and 3% were selected for this study. After mordanting, the pretreated fabric was dyed in 3 percent annatto dye solution for 45 minutes.

Post-Treatment

Annatto dyed fabric was post-treated with the 5 percent solution with each of the fixing agents such as vinegar, alum, ammonia, lime juice and calcium chloride.

Soaping Off

After post-treatment the samples are washed with 2 percent luke warm detergent solution to remove the excess colour on the fabric and then rinsed in water and dried.

Evaluation of Colour Fastness to Perspiration

The Bureau of Indian standard test procedure IS 971-1956 was used to test the colourfastness of the dyed specimens to alkaline and acidic perspiration.

- Acidic Test Solution

  The test solution was prepared by dissolving 3g of sodium chloride and 0.15g of urea per litre of water and P^H was adjusted to 5.6 by the addition of acetic acid.

- Alkaline Test Solution

  The test solution was prepared by dissolving 3g of sodium chloride per litre and adjusting the P^H of the solution to 7.2 with the addition of sodium bicarbonate.

RESULT AND DISCUSSIONS

Table 1: Acidic Perspiration Fastness Properties of Annatto (bixaorellana) Dye On Cotton

Dye Percentage: 3%																			
Mordants: Alum, Stannous Chloride, Ferrous Sulphate																			
Alkali Conc. 1g/100ml.																			
Dyeing Time: 45 min.																			
Mordant	Mordant conc. G/100g of Fabric	Control			T1			T2			T3			T4			T5		
		CC	CS		CC	CS		CC	CS		CC	CS		CC	CS		CC	CS	
			C	S		C	S		C	S		C	S		C	S		C	S
Alum	5	2	3	2/3	3	4/5	4	3	4	3	3/4	4/5	3	3/4	4/5	3	3	4/5	3
	10	2	3	2/3	4	4/5	4	2	4	3	3/4	4/5	2/3	3/4	4/5	3	3	4/5	3
	15	2	3	3	3	4/5	4	3	4	3	3/4	4/5	2/3	3/4	4/5	3	3	4/5	3
Stannous chloride	1	2	3	3	4	4/5	4	3	4	3	3	4/5	3	3/4	4/5	3	3	4/5	3
	2	2	2/3	2/3	4	4/5	4	3	4/5	3	3	4/5	3/4	4	4/5	3	3	4/5	3
	3	2	2	3	4	4/5	4		4/5	2	3	4/5	3/4	4	4/5	3	3	4/5	3
Ferrous sulphate	1	2	2	2	4	4/5	4	5	4/5	4	3	4	3/4	4	5	2/3	3	4	2/3
	2	2	2	3	4	4/5	4	5	4/5	4	3/4	4	3	3/4	5	2/3	3	4	2/3
	3	2	2	3	4	4/5	4	5	4/5	4/5	3	4	3	3/4	5	2/3	3	4	2/3

Note: T1 - Vinegar, T2- Alum, T3 - Ammonia, T4 - Lime Juice, T5 - Calcium Chloride

Acidic Perspiration Fastness of Annatto Dye on Cotton

The fastness grades of annato dye control the samples show the poor resistance to the colour change in all the mordanted cottons due to acidic perspiration. Poor to fair resistance to the colour staining was found on both cotton and silk composite fabrics. Alum mordanted sample showed fair resistance to staining on cotton and fairly poor to fair resistance to the staining on the silk composite fabric. Stannous chloride mordanted cottons exhibited poor fair resistance staining on both cotton and silk composite fabrics. However, in case of ferrous sulphate mordanted samples poor resistance on cotton and poor to fair resistance to the staining on silk was observed.

Vinegar post treated cottons showed fair to good resistance to the colour change due to acidic perspiration and very good resistance to the staining on cotton and good resistance on silk composite fabrics. Alum mordanted cottons showed fair to good resistance to colour change and the rest of the samples had registered good resistance to the colour change. When compared to control vinegar post-treatment had contributed to the improvement in the acidic perspiration fastness in terms of colour change and colour staining.

Post-treated alum samples exhibited poor to excellent resistance to colour change due to acidic perspiration. However, the resistance to staining varied as per the mordant used. Alum pre-treated and post-mordanted cottons exhibited poor to fair resistance to colour change. While fair resistance was found in stannous chloride mordanted samples, ferrous sulphate mordanted cottons possessed excellent resistance to colour change. Stannous chloride and ferrous sulphate mordanted cottons exhibited very good resistance to staining on cotton and alum samplers showed only good resistance. While stannous chloride mordanted silk showed poor to fair resistance, ferrous sulphate mordanted silk exhibited good to very good resistance. Alum post-treated cottons registered increase in the colour change with increased resistance than control.

Ammonia after treatment, samples had invented fair to very fair resistance to the colour change. Alum mordanted cottons showed very fair resistance to the colour change with slight staining on cotton and considerable staining on silk. Exhibited fair resistance to the colour change with good to very good resistance to staining on cotton and fair to very fair resistance to staining on silk was displayed for stannous chloride and ferrous sulphate mordanted cottons. When compared to control, post-treatment with ammonia had helped in improving the resistance to the colour change and staining on both cotton and silk composite fabrics in all mordanted cottons due to acidic perspiration.

Post-treatment with lime juice exhibited very fair to good resistance to the colour change with good to very good resistance to staining on cotton and fairly poor to fair resistance on silk due to acidic perspiration. While alum and stannous chloride mordanted cottons showed very good resistance to the colour staining on cotton, ferrous sulphated mordanted samples exhibited good resistance. Fair resistance to staining on silk was observed in case of alum and stannous chloride samples and fairly poor resistance was observed in ferrous sulphate mordanted cottons.

When compared to the control, lime juice post-treated cottons had contributed for improved resistance to colour change and staining to acidic perspiration. Treatment with calcium chloride on mordanted annatto dyed cottons registered fair resistance to colour change due to acidic perspiration. In case of alum and stannous chloride mordanted samples very good resistance to staining on cotton and fair resistance to staining on the silk composite fabric was observed. Ferrous sulphate mordanted cottons exhibited good resistance to staining on cotton and poor resistance on silk composite fabric. However, when compared to the control, post-treatment with calcium chloride showed improvement in the resistance to the colour change and staining due to acidic perspiration **(Table 1& Figure 3).**

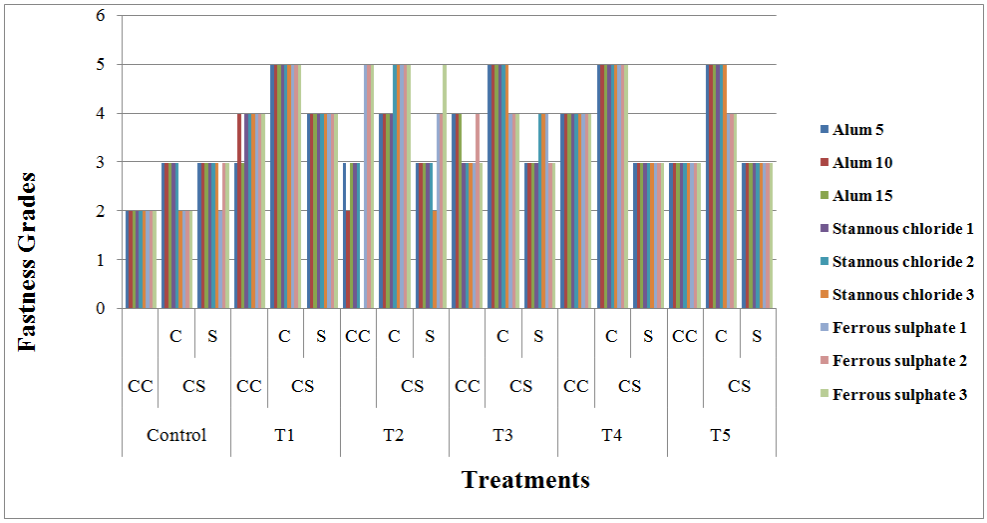

Figure 3: Acidic Perspiration Fastness of Annatto Dye On Cotton

Note: T1 - Vinegar, T2 - Alum, T3 - Ammonia,
T4 - Lime Juice, T5 - Calcium Chloride

Table 2: Alkaline Perspiration Fastness Properties of Annato (Bixaorellana) Dye on Cotton

Dye Percentage: 3%																				
Mordants: Alum, Stannous Chloride, Ferrous Sulphate																				
Alkali Conc. 1g/100ml.																				
Dyeing Time: 45 min.																				
Mordant	Mordant conc. G/100g of Fabric	Control			T1			T2			T3			T4			T5			
		CC	CS		CC	CS		CC	CS		CC	CS		CC	CS		CC	CS		
			C	S		C	S		C	S		C	S		C	S		C	S	
Alum	5	3	2	2	4	3	2/3	3	2	3	4	2	3	3	2	3		2	3	
	10	2	2	2	4	3	2	2/3	2	3	4	2	3	3	2	3	5	2	3	
	15	2	2	2	4	3	2	3	2	3	4	2	3	2	2	3	5	2	3	
Stannous chloride	1	2	1	2	4	2	2	3	2	3	4	2	3	3	2	3	5	1	3	
	2	2	2	1	4	2	2	3	4/5	3	3	3	3	3	1	3	5	2	3	
	3	3	2	1/2	4	2	2	3	4/5		4	3	3	2/3	1	3	5	2	3	
Ferrous sulphate	1	3	2	2	4	2	2	2/3	4/5	2/3	2	3	2	3	1	3	5	2	3/5	
	2	3	2	2	4	2	2	3	4/5	3	3	3	3	3	2	3	5	3	3/5	
	3	3	2	2	4	2	2	3	4/5	3	3	3	3	2/3	2	3	5	3	3/5	

Note: T1 - Vinegar, T2 - Alum, T3 - Ammonia, T4 - Lime Juice, T5 - Calcium Chloride

Alkaline Perspiration Fastness of Annato Dye on Cotton

The alkaline perspiration fastness of annatto dye on cotton mordanted with eco-friendly mordanted and post-treated with various fixing agents.

The fastness grades of annato dyed control sample exhibited poor to fair resistance to colour change with heavy staining on both the composite fabrics due to alkaline perspiration. While poor to fair resistance to colour change was observed in alum and stannous chloride mordanted cottons, fair resistance was observed in ferrous sulphate mordanted cottons. Heavy staining on both the composite samples were evident irrespective of the mordant used.

Post-treatment with vinegar had registered good alkaline perspiration in all mordanted cottons. However, the resistance to colour staining varied as per the mordant used from fairly poor to fair resistance. Alum mordanted cottons showed fair resistance on cotton and fairly poor resistance in silk. Poor resistances to staining on both the composite fabrics were recorded for both stannous chloride and ferrous sulphate mordanted samples when compared to control. Vinegar post-treatment had contributed for retaining the depth of colour after exposure to alkaline perspiration.

The alkaline perspiration grades of alum post-treated cottons showed fair to good resistance to the colour staining due to alkaline perspiration. Alum and stannous chloride mordanted cottons, except 10 percent alum mordanted samples, showed fair alkaline perspiration fastness. In ferrous sulphate mordated samples good resistance to the colour change was identified. As per the grades colour staining, it was observed that alum mordanted cottons showed improvement on silk. The rest of the cotton composite fabric samples showed on cotton composite fabric samples post-treated with alum had registered improvement in alkaline perspiration over control in terms of colour change.

Post-treatment with ammonia had registered poor to good resistance to colour change with poor to fair resistance to colour staining due to alkaline perspiration. Good resistance to colour change with heavy staining on cotton and slight improved resistance on the silk composite fabric was found in alum mordanted cottons. Stannous chloride mordant cottons had fair to good resistance to colour change and improved resistance to stains on both cotton and silk composite fabrics were observed. Ferrous sulphate mordanted cottons showed poor to fair resistance to colour change with fair resistance to colour staining on cotton and poor to fair resistance on silk. When compared to the control, post-treatment with ammonia

had contributed to the improvement in the resistance to the colour change and staining in all mordanted cottons.

Post-treatment with lime juice had registered only fairly poor to fair resistance to colour change and very poor to fair resistance to the colour staining due to alkaline perspiration. Stannouschloride and ferrous sulphate mordanted cottons showed very fairly poor to fair resistance to the colour change followed by alum mordanted samples which showed poor to fair resistance to the colour change. In all mordanted samples, poor resistance to staining on cotton composite fabrics and fair resistance was observed on silk composite fabric. However, stannous chloride showed decreased resistance to staining on cotton. When compared to the control, post-treatment with lime juice did not contribute for any significance in improving in majority of the mordanted samples. However, resistance to staining was improved on the silk composite fabric. Calcium chloride post-treated cottons showed excellent resistance to the colour change in all mordanted cottons due to alkaline perspiration. However, resistance to colour staining varied according to the mordant used. Alum and stannous chloride mordanted cottons exhibited poor resistance to the staining on cotton. Whereas, poor to fair resistance to the staining was found in ferrous sulphate mordanted cottons and exhibited, fair resistance to the staining was registered on silk composite fabric. In case of alum and stannous chloride mordanted samples. While, ferrous sulphate mordanted cottons showed very fair resistance to the staining on silk when exposed to alkaline perspiration when compared to the control post-treatment with calcium chloride had contributed for improvement in retaining the depth of the shade and increased resistance to staining on silk**(Table 2 & Figure 5).**

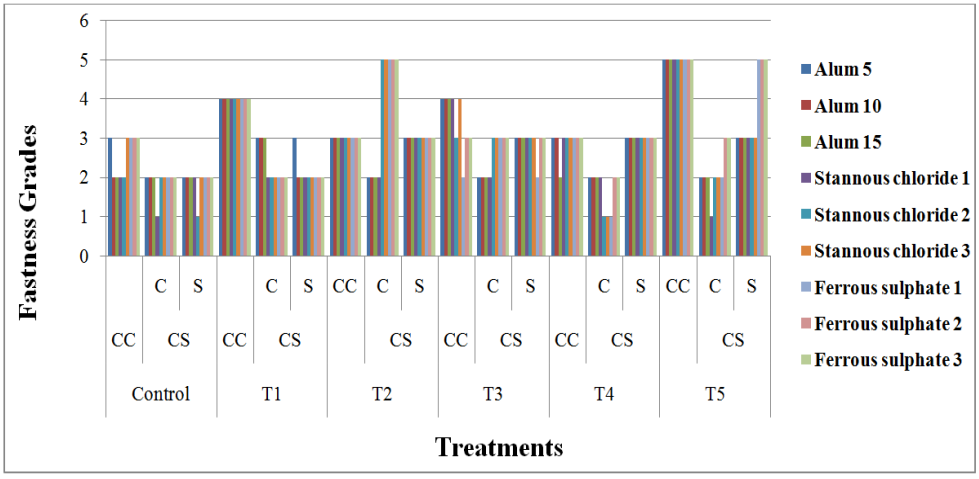

Figure 5: Alkaline Perspiration Fastness of Annato Dye on Cotton

Note: T1 - Vinegar, T2 - Alum, T3 - Ammonia,
T4 - Lime Juice, T5 - Calcium Chloride

CONCLUSIONS

Vinegar post-treated samples displayed an increased depth of the shade on the cottons mordanted with alum, stannous chloride and ferrous sulphate, also providing leveled shades in the acidic and alkaline perspiration fastness greater than control.

The alum post-treated samples produced better shades than control in case of alum and ferrous sulphate pre-mordanted cottons and increased level dyeing was observed in all the mordanted samples. Resistance to the colour change and colour staining due to acidic per perspiration was increased. Improvement in alkaline perspiration was observed over control.

Post-treatment with ammonia had showed improvement in both acidic and alkaline perspiration of all mordanted cottons was noted.

Post-treatment with lime juice samples exhibited increases in depth of the shade and added for level dyeing in all mordanted samples.

The acidic perspiration of all mordanted samples increased with improved resistance to staining over control. When compared to the control majority of the sample did not show any significant improvement in resistance to the colour change, but resistance to staining on the silk composite fabric was increased after being exposed to alkaline perspiration.

Calcium chloride post-treated cottons did not register any change in the shade over control. The acidic perspiration fastness of alum and ferrous sulphate mordanted cottons improved and graded as good to very good, with improved resistance to staining on the cotton composite fabric over control. When compared to control, post-treatment with calcium chloride had contributed to improvement in the depth of the colour and increased resistance to staining on silk. Cotton composite fabrics did not show any improvement in resistance to staining due to alkaline perspiration.

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